

## SECTION 16070

### HANGERS, SUPPORTS, AND SEISMIC PROTECTION

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#### **LANL MASTER CONSTRUCTION SPECIFICATION**

When editing to suit Project, author shall add job-specific requirements and delete only those portions that do not apply to the Project (e.g., a component that does not apply). Contact the Engineering Standards Manual (ESM) Electrical POC to seek a variance from applicable requirements. Refer to

[http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc\\_techcom1.htm#elec](http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm#elec) for the Engineering Standards Manual Personnel Link Index.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

This specification addresses seismic protection requirements for Performance Category (PC) 1 and PC-2 electrical components. Refer to ESM Chapter 5 – *Structural* for seismic protection design requirements that are required for PC-1 and PC-2 components. Also refer to ESM Chapter 5 – *Structural* for additional seismic protection design requirements that will be required for PC-3 and PC-4 components.

Use this specification in conjunction with Section 13085 *Seismic Protection*.

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#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Design, furnish, and install, hangers, supports, anchors, concrete bases, sleeves, inserts, seals, and other positive fastenings for electrical components such that in-service loads and seismic forces are safely transferred to the structure and relative seismic displacements of supporting structures are adequately accommodated.

##### 1.2 SEISMIC PROTECTION

- A. The requirements for seismic protection measures described in this section apply to all electrical components except for the following:
  - 1. Electrical components where  $I_p = 1.0$ , and flexible connections between the components and associated conduits are provided, and the components are mounted at 4 ft or less above the floor, and the components weigh 400 lb or less.
  - 2. Electrical components weighing 20 lb or less where  $I_p = 1.0$  and flexible connections between the components and associated conduits are provided.
  - 3. Electrical distribution systems weighing 5 lb/ft or less where  $I_p = 1.0$ .
  - 4. Seismic restraints are not required for electrical conduit less than 2-1/2 inches trade size and not containing conductors for life-safety, safety-significant, or safety-class systems; provide seismic protection for all other interior conduit as specified.

- B. Design, furnish, and install seismic protection in accordance with the *IBC*, ASCE 7, and additional data furnished in this Section and Section 13085 *Seismic Protection*. Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads.
- C. Design the functional and physical interrelationship of components and their effect on each other so that the failure of an electrical component shall not cause the failure of a nearby life-safety, safety-significant, or safety class mechanical or electrical component.
- D. Seismic Criteria: Use the following criteria to calculate seismic design forces and relative seismic relative displacements in accordance with the *IBC* and ASCE 7.
  - 1. Seismic Design Category = D
  - 2.  $S_{DS}$  = spectral acceleration, short period  
 $S_{DS} = 0.54g$
  - 3.  $a_p$  = component amplification factor  
 $a_p = 2.5$  for electrical distribution systems such as busducts, conduit, cable tray  
 $a_p = 1.0$  for electrical equipment such as switchgear, transformers, batteries  
 $a_p = 1.0$  for luminaires
  - 4.  $R_p$  = component response modification factor  
 $R_p = 5.0$  for electrical distribution systems such as busducts, conduit, cable tray  
 $R_p = 2.5$  for electrical equipment such as switchgear, transformers, batteries  
 $R_p = 1.5$  for luminaires  
 $R_p = 1.5$  for components anchored by shallow expansion anchors, shallow chemical anchors, or shallow (low deformability) cast-in-place anchors
  - 5.  $I_p$  = Component importance factor  
 $I_p = 1.5$  for life safety related components such as emergency generators  
 $I_p = 1.5$  for components with hazardous content such as lead-acid batteries  
 $I_p = 1.5$  for safety class or safety significant components.  
 $I_p = 1.0$  for all other components

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**Edit the following article to match project conditions; add items to list as required; delete items not included in the Project. It may be necessary to note the equipment IDs for the particular items of equipment (e.g. GDE-1, SUS-B, etc.) that must meet the requirements of this article. Delete the article if there is no equipment with  $I_p$  greater than 1.0.**

**NOTE: Seismic protection does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, consult the manufacturer regarding the capabilities of the equipment to withstand seismic loading.**

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- E. Equipment Qualification: The following equipment designated with  $I_p$  greater than 1.0 and furnished under this contract shall be certified by the manufacturer to withstand the total lateral seismic force and seismic relative displacements specified in the *IBC* or ASCE 7. Component manufacturer's certification shall be based on shake table testing or experience data (ie., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety. Required response spectra shall exceed 1.1 times the in-structure spectra determined in accordance with IBC AC156 *Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems*.

1. Engine-generator[s] [GDE-1]
2. Secondary Unit Substation[s] [SUS-B]
3. Transformer[s] [XFMR-3]
4. Switchboard[s] [SWBD-2]
5. Motor control center[s] [MCC-E]
6. [ ]

### 1.3 QUALITY ASSURANCE

- A. Design, provide, and install hangers, supports, and seismic protection that conforms to the requirements of the following codes and standards:
  1. *National Electrical Code (NEC)*
  2. *International Building Code (IBC)*
  3. *ASCE 7-02 Minimum Design Loads for Buildings and Other Structures*
  4. *NECA 1 Standard Practices for Good Workmanship in Electrical Construction (ANSI).*
- B. Retain the services of a Registered Professional Engineer to design fabricated hangers, supports, and seismic protection for components for which shop drawings are required in the SUBMITTALS clause of this section.
- C. Where Underwriters Laboratories, Inc. has requirements for such products, provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

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**Edit the following article to match project requirements.**  
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### 1.4 SUBMITTALS

- A. Submit the following in accordance with the provisions of Section 01330 *Submittal Procedures*.
- B. Catalog Data: Submit catalog data for each type of product specified. Include information substantiating equivalent corrosion resistance to zinc coated steel of alternative treatment, finish, or inherent material characteristic.
- C. Material List: Submit hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

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**Edit the following articles to match project conditions; add items to list as required; delete items not included in the Project.**  
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- D. Shop Drawings: Submit shop drawings showing details of fabricated hangers, supports, and seismic protection of the components listed below. Provide detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the components listed below. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

1. Luminaires
2. Cable trays
3. Wireways
4. Bus ducts
5. Individual conduits on hangers
6. Trapeze supported multiple conduits
7. Switchboards
8. Transformers
9. Panelboards
10. Safety switches and enclosed circuit breakers
11. Motor controllers and combination starters
12. Motor control centers
13. Battery racks or cabinets
14. Uninterruptible power systems
15. Engine-generator systems
16. [ ]

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**Edit the following article to match project conditions; delete if not required by Project.**  
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- E. Calculations: Submit Design Calculations with the Shop Drawings. Calculations shall be stamped and signed by a Registered Professional Engineer in responsible charge of the design. Calculations shall verify the capability of attachments and structural members to which attachments are made for carrying the combined loads of each attachment.

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**Edit the following article to match project conditions; delete if not required by Project.**  
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- F. Certifications: Submit manufacturer's certification of compliance indicating compliance with Clause 9.6.3.6 of ASCE 7 for electrical components with  $I_p$  greater than 1.0. Submit shake-table test results or experience data with certifications.

## 1.5 RECEIVING, STORING AND PROTECTING

- A. Receive, store, and protect, and handle products according to NECA 1.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. Refer to Section 13085 *Seismic Protection* for general seismic protection materials and equipment.

### 2.2 COATINGS

- A. Provide products for use indoors protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
- B. Provide products for use outdoors or in damp or corrosive indoor locations with hot-dip galvanized coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

### 2.3 RACEWAY SUPPORTING DEVICES

- A. Provide supports as described below for the installation of raceway systems.
- B. Use pressed steel, single bolt hangers to support individual RGS, IMC or EMT conduit runs from threaded rods or beam clamps. Manufacturer: Steel City "6H Series".
- C. For individual runs of EMT up to 1 inch trade size above accessible ceilings, use spring steel conduit clips with positive snap closure. Manufacturer: ERICO CADDY "M Series".
- D. Use malleable iron conduit clamps to secure individual RGS, IMC or EMT conduit runs across, parallel, or perpendicular to beams, channels and angle supports. Manufacturer: Steel City "RC, EC, and PC Series".
- E. Use two-piece carbon steel riser clamps for individual vertical conduits passing through floors. Manufacturer: Kindorf "C-210 Series".
- F. Use snap-on type one-hole steel straps to secure individual conduits up to 2 inch trade size to flat, dry interior surfaces. Manufacturer: T&B "1210 Series" for RGS and IMC and "4100 Series" for EMT.
- G. Use one-hole malleable iron straps to secure individual conduits up to 4 inch trade size to flat, dry interior surfaces. Manufacturer: T&B "1275 Series".
- H. Use one-hole malleable iron straps and conduit spacers to secure individual conduits to flat exterior or damp flat interior surfaces. Manufacturer: T&B "1275 Series" straps with 1350 Series" spacers.

- I. Support multiple parallel horizontal conduits with trapeze hangers fabricated from framing channel materials specified below.

## 2.4 OUTLET BOX SUPPORTING DEVICES

- A. Provide pre-fabricated sheet steel brackets to support outlet boxes from metal studs in dry-wall construction.
- B. Provide brackets for single outlet boxes that are inset to allow for drywall ring and have a far side support leg. Manufacturer: ERICO CADDY "H Series".
- C. Provide brackets for multiple outlet boxes that are inset to allow for drywall rings and span from stud to stud. Manufacturer: ERICO CADDY "RBS Series".

## 2.5 FASTENERS

- A. Provide fasteners of the types, materials, and construction features as follows:
  - 1. Pre-set concrete inserts:
    - a. Continuous inserts: Design load 2000 lbs per ft of insert length with safety factor of 3 in 3000 psi concrete. Manufacturer: B-Line "B221"
    - b. Spot inserts: NRTL-listed with design load of 1000 lb. Manufacturer: B-Line "B2506"
    - c. Metal deck bolts: Adjustable with bolt sizes from 3/8 inch to 3/4 inch. Manufacturer: B-Line "B3019"
  - 2. Expansion anchors: NRTL listed carbon steel wedge type studs. Manufacturer: Hilti "Kwik Bolt II". Note restrictions on use of expansion bolts in Part 3 of this Section.
  - 3. Toggle bolts: All steel spring head type.
  - 4. Masonry screw anchors: Case hardened steel. Manufacturer: Hilti "Kwik-Con II".
  - 5. Powder-Driven Threaded Studs: Heat-treated steel, designed for the intended service. Note restrictions on use of powder-driven fasteners in Part 3 of this Section.
  - 6. Beam clamps: NRTL-listed, or compliant with Federal Specification WW-H-171E, or compliant with Manufacturers' Standardization Society SP-69 and SP-58.

## 2.6 FRAMING CHANNEL SYSTEMS

- A. Provide U-channel framing systems that conform to the Metal Framing Manufacturers' Association standards publication MFMA-4 and are fabricated using minimum 12-gage steel, with 9/16-inch-diameter holes, from 1-1/2 to 1-7/8 inches on center, in the surface opposite the "U" opening.
- B. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer. Use two-piece, single bolt type conduit straps on U-channel supports.
- C. Manufacturers: Unistrut, B-Line, Superstrut.

## 2.7 FABRICATED SUPPORTING DEVICES

- A. Provide shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Provide steel brackets fabricated from angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

## 2.8 SLEEVES AND SEALS

- A. Provide pipe sleeves of one of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap-lock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
    - a. 3-inch and smaller: 20-gage.
    - b. 4-inch to 6-inch: 16-gage.
    - c. over 6-inch: 14-gage.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe two pipe sizes larger than the penetrating raceway.
  - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe two pipe sizes larger than the penetrating raceway.

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**Delete the following article except where watertight seals are required. Coordinate with Drawings and Section 16130.**  
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- B. Provide factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Provide seals complete with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, clamps, and cap screws. Manufacturer: O-Z/Gedney "Type CSM Series".

## 2.9 CONCRETE FORMWORK

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**Edit the following article to match specification sections used in Division 3.**  
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- A. Refer to Section [03100 Concrete Formwork] [03300 Reinforced Concrete].

## 2.10 CONCRETE REINFORCEMENT

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**Edit the following article to match specification sections used in Division 3.**  
\*\*\*\*\*

- A. Refer to Section [03200 Concrete Reinforcement] [03300 Reinforced Concrete].

## 2.11 CAST-IN-PLACE CONCRETE

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**Edit the following article to match specification sections used in Division 3.**  
\*\*\*\*\*

- A. Refer to Section 03310 Cast-In Place Concrete] [03300 Reinforced Concrete].

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Install hangers, supports, anchors, concrete bases, sleeves, inserts, seals, and other positive fastenings for electrical components such that all IBC required loads, including calculated seismic forces, are transferred to the structure through load paths with adequate strength and stiffness.
- B. Install hangers, supports, and seismic protection according to the *NEC*, *IBC*, *ASCE 7*, *NECA 1*, and requirements in this Section.
- C. Conform to manufacturer's instructions and recommendations for selection and installation of hangers, supports, and seismic protection.
- D. Do not use wire or perforated strap for permanent electrical supports.
- E. Locate and attach each item of rigid electrical equipment entirely on one side only of a building expansion joint. Provide piping, electrical conduit, etc., which cross an expansion joint to rigid electrical equipment with flexible joints that are capable of accommodating calculated thermal and seismic displacements.
- F. Refer to Section 13085 *Seismic Protection* for general seismic protection installation requirements.

### 3.2 EXAMINATION

- A. Examine surfaces to receive hangers, supports, and seismic protection for compliance with installation tolerances and other conditions affecting performance of the system. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.3 RACEWAY SUPPORTS.

- A. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
- B. Support three or more parallel runs of horizontal raceways together on trapeze hangers.
- C. Support individual horizontal raceways by separate pipe hangers.
- D. Do not support conduits from ceiling suspension wires.



### 3.4 BOXES AND CABINETS

- A. Support sheet metal boxes directly from the building structure or by approved brackets or bar hangers. Where bar hangers are used, attach the bar to structure on opposite sides of the box.
- B. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support.
- C. Install surface-mounted cabinets and panelboards with minimum of four anchors.

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**Edit the following article to match project conditions; delete if concrete bases are not required.**

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### 3.5 CONCRETE BASES

- A. Install a reinforced concrete base, not less than 4 inches high, for each floor mounted electrical equipment.

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**Edit the following article to match project conditions; delete if not required. Use concrete bases with a permanent steel perimeter for heavy equipment such as unit substations, transformers 300 kVA and larger, engine generators, etc. Edit references to concrete work to match sections used in Division 3 of the Project Specifications.**

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- B. Support each [unit substation] [engine generator] [rotary UPS] [transformers 300 kVA and larger] [ ] on a concrete equipment base with a permanent steel perimeter frame.
  - 1. Form base using ASTM A-36 steel channels.
  - 2. Construct base not less than 4 inches larger in both directions than supported equipment. Miter and weld corners and provide cross bracing. Anchor or key to floor slab.
  - 3. Install reinforcing bars tied to frame, and place anchor bolts, floor sills and sleeves using manufacturer's installation template. Refer to Section [03200 Concrete Reinforcement] [03300 Reinforced Concrete].
  - 4. Place concrete and provide a steel trowel finish on top. Refer to Section 03310 Cast-In Place Concrete] [03300 Reinforced Concrete].
  - 5. Clean exposed steel frames and apply 2 coats of rust-preventative metal primer and 2 coats of exterior, gloss, alkyd enamel in color selected by the Architect.

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**Edit the following article to match project conditions; delete if not required. Use concrete bases without a permanent steel perimeter for relatively light floor-mounted equipment such as transformers smaller than 300 kVA, motor control centers, switchboards, etc. Edit references to concrete work to match sections used in Division 3 of the Project Specifications.**

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- C. Support each [switchboard] [power panelboard] [motor control center] [transformers smaller than 300 kVA] [ ] on a formed concrete equipment base.
1. Form concrete equipment bases using framing lumber with form release compounds. Refer to Section [03100 Concrete Formwork] [03300 Reinforced Concrete].
  2. Construct concrete base not less than 4 inches larger in both directions than supported unit.
  3. Install reinforcing bars, and place anchor bolts, floor sills and sleeves using manufacturer's installation template. Refer to Section [03200 Concrete Reinforcement] [03300 Reinforced Concrete].
  4. Place concrete and provide a steel trowel finish on top; chamfer top edges and corners. Refer to Section [03310 Cast-In Place Concrete] [03300 Reinforced Concrete].
- D. Cure concrete not less than seven days before installing equipment.

### 3.6 ANCHOR BOLTS

- A. Use cast-in-place anchor bolts for electrical equipment mounted on masonry walls, concrete floors or concrete pads. Do not use expansion or chemically bonded anchors without first considering the increased design force requirements for such anchors in the SEISMIC PROTECTION paragraphs of Part 1 of this Section.
- B. Provide anchor bolts conforming to the equipment manufacturer's installation recommendations or as indicated on the Drawings, whichever is the most stringent. Extend anchor bolts that exceed normal depth of equipment concrete bases into the concrete floor or the foundation as necessary to accommodate bolt lengths.
- C. Select anchors embedded in concrete or masonry to carry the least of the following loads, taking into account the expected conditions of installation including eccentricities and prying effects:
1. The design strength of the connected part
  2. 1.3 times the force in the connected part due to the combined prescribed forces
  3. The maximum force that can be transferred to the connected part by the component structural system

### 3.7 HANGER RODS

- A. Use threaded hanger rods not less than the sizes scheduled below:
1. Individually hung conduits, 1/2 inch through 1-1/4 inch: 1/4 inch
  2. Individually hung conduits, 1-1/2 inch through 4 inch: 3/8 inch
  3. Trapeze hung conduits, 10 foot maximum spacing: 3/8 inch

4. Trapeze hung conduits, 20 foot maximum spacing: 1/2 inch
5. Cable tray: 1/2 inch

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**Coordinate the following article with the Drawings. Delete if there is no suspended equipment.**  
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- B. Use hanger rods to support suspended equipment as indicated on the Drawings.

### 3.8 SWAY BRACING

- A. Refer to Section 13085.

### 3.9 FASTENING

- A. Unless otherwise indicated, fasten electrical components and their supporting hardware securely to the building structure.
- B. Select each fastener so that the load applied to the fastener does not exceed the manufacturer's recommended load for the fastener.
- C. Use powder-set anchors only for shear loads. Do not use powder-set anchors for tension loads.
- D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

### 3.10 SLEEVES AND SEALS

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**Edit A to match Project requirements.**  
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- A. Install sleeves in concrete slabs and walls and all other fire- rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply NRTL- listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables. Follow manufacturer's instructions to restore original fire rating of wall or slab.

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**Edit B to match Project requirements.**  
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- B. Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- C. Request inspection of firestop installations by the LANL Authority Having Jurisdiction both before and after installation of firestop materials.

END OF SECTION

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**Do not delete the following reference information.**

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FOR LANL USE ONLY

This project specification is based on LANL Master Construction Specification Section 16070 Rev. 0, October 28, 2004.